On the Nature of the Orbit of γ Lupi. By T. J. J. See, A.M., Ph.D. (Berlin).

The brilliant southern binary *γ Lupi* was discovered by Sir John Herschel, at the Cape of Good Hope, 1834 June 9. The measures secured by him during the next four years define the place of the companion at that epoch with considerable precision; and, as might have been predicted from the appearance of this striking system, time has shown that it is in orbital motion. After Herschel's return to England a long period elapsed before it was again resolved by any telescope in the southern hemisphere, though it was frequently examined with instruments at least equal to that employed in the earliest work at the Cape.

Mr. Russell, of Sydney, deserves our special thanks for the records secured by him from 1874 to the present time with his $11\frac{1}{2}$-inch telescope, which under good conditions ought to separate a nearly equal pair like *γ Lupi* at a distance of $0''.4$. For, although these records are of a negative character, they possess the highest interest. The fact that Mr. Russell and his assistants examined this object on many occasions prior to 1880, without being able to divide it, long ago made known that it had narrowed up after the time of Herschel. As the Sydney observers are still unable to divide it, the observations recently secured by Mr. Cogshall and the writer with the Lowell 24-inch refractor at Mexico are the first actual measures of the system for sixty years. These data define the present position of the companion with a high degree of precision, and throw an interesting light upon the character of the orbit; and hence I submit herewith the conclusions at which we have arrived. We swept over the star (unaware that it was *γ Lupi*) on the morning of 1897 January 17, and I saw at once that it was double, and indeed divided clearly, though by no means a very easy object even with the great telescope. It was subsequently re-examined on several nights, and no difficulty was experienced in securing good measures; yet when the seeing was deteriorated it became difficult to measure, and thus during our later work this well-known object served as a most trustworthy and convenient index to the state of the atmosphere. Here at Flagstaff, notwithstanding the low altitude of only 14°, the fine seeing afforded by our location has enabled me to divide it on several occasions during the past summer. The following are all the observations to the present time:—

Complete Observations of γ Lupi.

t	*θ*	*ρ*	*n*	Observers.	Remarks.
1834·504	98°·5	0·72	3	Herschel	Refractor.
1835·335	94·8	0·85	6–2	,,	,,
1836·282	93·0	1·00	2–1	,,	,,
1836·523	95·5	0·67	1	,,	Reflector
1837·265	94·8	0 67	4–2	,,	Refractor
1871·465	Well defined but not divided.		...	Russell	7½-inch refractor.
1877·502	270° ± smaller end goes first.		...	,,	11½-inch; powers 480, 800, 1,200.
1880·578	270 ± elongated.		...	,,	
1881·548	Round, with powers to 800.		...	,,	
1886·570	Uncertain elong. in 90°.		...	,,	Definition not good.
1886·570	Round, with all powers on 7½-inch telescope.		...	Pollock	
1887·531	Single, with 800 on 11½-inch.		...	,,	Never saw better definition; *γ Lupi* is not like *ζ Sagittarii* measured on the same night. Dist. 0″·6.
1895·56	Single, good definition.		3	Sellors	
1897·065	92°·4	0″·34	2	See	Nicely separated.
1897·086	90·4	0·47	1	Cogshall	Divided.

Our measures indicate that the present distance is slightly less than 0″·4, and hence we may easily understand Mr. Russell's inability to divide it. He writes in a letter of August 30: "We have regularly looked at it, and always without dividing it. The last time it was in a favourable position, Mr. Sellors examined it several times, and could see no sign of division." Herschel's measures show that it was not very difficult in his time. Taking all the evidence into consideration, we may fix the place as substantially this:

1835·0 94° 0″·8

The distance at that epoch could hardly be less than 0″·8, for Herschel remarks: "Clearly divided with power of 480, and black division well seen; well separated with 800." And in speaking of *π Lupi* he says: "Excessively difficult. It is closer than *γ Lupi*, for the discs are smaller, and yet are not so much divided." "I do not think better measures of this star will be got

with this instrument." Herschel made the distance of *π Lupi* 0″·67 (on other occasions about 0″·80); and as this object is known by more recent measures to be steadily widening out, we may accept his distance of *π Lupi* as quite trustworthy. For taking the present distance (1″·30) of *π Lupi*, and going back in time, we find that in 1835 it must have been separated by at least 0″·75. Assuming, therefore, that *γ Lupi* was separated by 0″·8 in 1835, we may summarise the case as follows :—

1. The present position in 92°, 0″·34 shows that the plane of the orbit passes nearly through the Sun, and that the companion thus oscillates in a right line like that of 42 *Comæ Berenicis* (*Monthly Notices*, 1896 November).

2. Assuming that the distance was 0″ 8 in 1835, as indicated by the work of Herschel, the present distance, 0″·34, shows that in 1877 it ought to have been easily separated with an 11½-inch telescope had the companion merely narrowed up at about a constant rate without yet occulting the large star; for on this hypothesis the distance would then have been 0″·50. Mr. Russell made it on the opposite side, in 270°±, and presumably at a distance of about 0″·35. In describing the image he expressly notes that the "smaller end goes first"

3. In view of Mr. Russell's inability to divide the object in 1877, we may infer that the distance had certainly become less than 0″·4, and that the companion had widened out to about this distance on the other side. It is thus clear that the companion has passed periastron, and is now again approaching the position where Herschel saw it in 1835.

4. We thus have satisfactory evidence that *γ Lupi* has already made a large part of a revolution, and that the situation of the orbit is similar to that of 42 *Comæ Berenicis*, which heretofore has been unique among all known stellar systems.

5. The period cannot yet be fixed with any precision, for we are unable to ascertain the distance to which the companion recedes in angle 93°. If the distance in the time of Herschel was about a maximum (which is not improbable) the period could be confined within a century.

It thus appears that the system of *γ Lupi* is in every way one of surpassing interest, and will deserve the constant attention of southern observers. If careful measures can be secured for the next twenty years, an approximate determination of the orbit will then be possible. The system has a very small proper motion, according to Auwers:

$$\text{in } \alpha = -0^{s}\cdot0054$$
$$\text{in } \delta = -0''\cdot037$$

Accordingly, there is a probability that this extraordinary binary is very remote and of large dimensions. If this conjecture be true, the brilliancy of the stars composing it shows that they are enormously luminous and probably of great mass.

The place for 1900·0 is

$$\alpha = 15^h\ 28^m\ 28^s{\cdot}4$$
$$\delta = 40^\circ\ 49'\ 50''{\cdot}2$$

While the present results indicate the general character of the motion, it is obvious that the work of many years will be required to define the orbit with great accuracy; yet I have thought proper at this time to direct attention to the first fruit of what must be considered to be one of the most fortunate of Herschel's discoveries made more than sixty years ago.

Lowell Observatory, Flagstaff, Arizona:
1897 *October* 1.

List No. 4 for 1900·0 *of Nebulæ discovered at the Lowe Observatory, California.* By Lewis Swift.

No.	Date. 1897.	R.A. h m s	Dec. ° ′ ″	Descriptions.
1	Sept. 23	0 11 0	−39 52 20	eeeF, vL, eE, close f 55, f of 2. Note.
2	Oct. 3	0 54 30	−34 51 32	pB, vS, R, 2 st nf, and 2 np.
3	Sept. 29	1 5 0	−46 31 38	vF, S, R, no B ✶ near, vF one f.
4	29	1 53 4	−33 31 27	pB, vS, R, BM 10^m ✶ v close sp.
5	29	2 5 0	−33 25 0	vF, vS, eE, nearly 0°, F ✶ p.
6	29	2 59 28	−39 52 38	eF, pS, R, FD ✶ sf point to it.
7	26	3 31 0	−34 46 55	pB, S, eeeE, a straight hair-like line 90°. Note.
8	29	4 8 45	−33 7 51	eF, vS, R, BM, 10^m ✶ close s.
9	29	4 16 30	−31 41 42	eeF, pL, R.
10	Aug. 10	19 53 30	−38 47 38	vF, S, R, 8^m ✶ f, 90°, p of 2, same parallel.
11	10	19 54 0	−38 47 38	vF, S, R, 8^m ✶ f, f of 2.
12	July 8	20 0 0	−48 35 50	B, cE, vS, stellar, f of 2.
13	Sept. 23	20 10 59	−41 53 24	vF, cS, R, no B ✶ near.
14	16	20 24 25	−36 39 15	vF, cS, R, several pB st sf.
15	17	20 40 25	−38 50 35	eeF, pS, R.
16	15	21 1 31	−30 26 30	eeF, pS, R, F ✶ near f, 90°.
17	17	21 41 0	−35 21 58	vF, vS, R.
18	17	21 42 0	−35 27 0	vF, pL, R. Not 7130 or 7135; sp of 2.
19	17	21 43 30	−35 22 10	eeF, pL, R, 3 B st p = △ nf of 2.
20	27	21 49 46	−49 31 52	eeF, pS, R, in line with 2·9^m st sf, 7^m ✶ in field sf.
21	23	22 51 30	−43 59 27	pB, S, R, mbM.
22	Oct. 3	23 27 45	−45 35 40	vF, S, R, bet 2 st, 8^m ✶ sf and 7^m ✶ sp.
23	Sept. 23	23 39 25	−43 29 15	eF, eS, R, stellar.
24	25	23 42 40	−37 36 53	eeF, CS, R, in vacancy.
25	25	23 52 25	−37 34 52	pB, CS, eE, 1 star near sf.